Introduction to the Atmosphere
Chapter 3

Atmosphere, Weather and Climate

- General Composition of the atmosphere
  - Temperature
  - Pressure and Wind
  - Moisture
  - Flows and Disturbances (Weather)
  - Zones and Types (Climate)

What will be covered in this Chapter

- The Size of the Earth's Atmosphere
- Composition of the Atmosphere
- The Vertical Structure of the Atmosphere
- Human-Induced Changes in the Atmosphere
- General Weather and Climate

Size of the Earth's Atmosphere

- Extends outward at least 6000 miles,
- More than half of the mass of the atmosphere found below 3.8 miles
- More than 98% lies with 16 miles of sea level
- Humans are creatures of the atmosphere

Size of the Atmosphere

- What is the composition of the Atmosphere
  - Permanent Gases
  - Nitrogen and Oxygen make up the 99 % of the atmosphere
  - 78% Nitrogen
  - 21% Oxygen
  - Other 1%
  - Argon .9%
  - Carbon Dioxide .038%
  - All other gases .06% equaling .998%

Other Significant Gases

- Water Vapor
  - Invisible

    - Visible
- Clouds
- Precipitation (liquid or solid)
    - Abundant in air overlying warm, most surface areas, like tropical oceans measuring up to as much as 4% of the volume of the air mass
    - Over deserts or polar regions it would make up less than 1% of the volume.
- Carbon Dioxide (CO2)
    - Significant to the climate because of its ability to absorb infrared radiation, which helps warm the lower part of the atmosphere
    - Distributed evenly throughout the lower atmosphere.
    - Increasing during the last century at a rate of about .0002 percent.
    - Increased levels of Carbon Dioxide are causing the lower atmosphere to produce somewhat unpredictable climate changes (global warming)
- Another minor vital gas in the atmosphere is Ozone
    - Mostly concentrated in the Ozone layer.
    - Between 9 to 30 miles above sea level
    - Ozone is excellent as an absorber of ultraviolet solar radiation and its deadly effects.
- Carbon monoxide, sulfur dioxide, nitrogen oxides, and various hydrocarbons.
    - All hazardous to life and may possibly effect the climate

Particulates (Aerosols)

- Large nongaseous particles in the atmosphere
    - Mainly liquid water and ice
    - Clouds, rain, snow, sleet, and hail
- Dust particles large enough to be visible, but too heavy to fall to the ground
    - Smaller particulates a invisible to the naked eye, may also be suspended in the atmosphere
    - Found near their origin, either urban areas, or the natural condition that caused the particulate

Affects on Weather and Climate

- 1. Many of the particulates are hygroscopic (absorbs water). The water vapor condenses around the particulates as they float by. Accumulation of water vapor molecules is a critical step in cloud formation.
- 2. Some either absorb or reflect sunlight, thus decreasing the amount of solar energy that reaches Earth's surface.

Vertical Structure of the Atmosphere

- Thermal layers of the atmosphere
  - Troposphere and Tropopause
  - Lowest level, closest to sea level
  - 11 miles at equator to 8 miles at poles
  - Deepest over the tropical regions
  - Shallow over the poles
  - Varies with the passages of warm and cold air
- Stratosphere and Stratopause
  - Extends from 11 miles above sea level to 30 miles above sea level
  - Upper Thermal Layers
- Mesosphere and Mesospause
  - Begins 30 miles and ends 50 miles above sea level
- Thermosphere
  - Begins at 50 miles and gradually extends out
- Exosphere
  - Outer most portion of the atmosphere
  - Blends with interplanetary space
  -

Temperature of the Atmospheric Layers

- Troposphere:
  - The temperature decreases with the increase of altitude
  - Average temperature is 59^{o} at the surface
  - Average temperature at the top -71^{o}
  - Tropopause: Several miles where the top temperature stays constant
- Stratosphere:
  - 20 miles above sea level to 30 miles the temperature rises
  - Average temperature at the top 28^{o}.
  - Stratopause: Several miles where the top temperature stays constant
- Mesosphere :
  - 30 miles above sea level to 50 miles the temperature falls
  - Average temperature at top -80^{o}.
  - Mesopause: Several miles where the top temperature stays constant
- Thermosphere :
  - Temperature increases to an altitude of 125 miles about sea level
- Exosphere:
  - Outer layer of the atmosphere
  - No concept of temperature

Warm Zones/Cold Zones

- "Warm Zones"
  - Zone that has a specific source of heat
    - In Troposphere:
    - The surface of the Earth is the source
  - Top of the Stratosphere :
    - The Ozone layer absorbs ultraviolet rays , thereby warming the atmosphere
- "Cold Zones" are areas that simple don't have the warming sources

Pressures

- Atmospheric pressures are simply the "weight" of the overlying air.
- The taller the column of air the greater the pressure.
- So at sea level, the column of air above is longer thus the air pressure is higher, and the air is denser
- At a high altitude there is a smaller column of air, so the air pressure is lower and the air is less dense.
- <u>The decrease in air pressure decreases with altitude but not at a constant rate.</u>

Two other Vertical Compositional Layer of the Atmosphere

- <u>Ozonesphere</u>
  - 9 to 30 miles above sea level
  - Gets its name because the concentration of ozone is at its highest
  - Found in the Stratosphere
- <u>Ionoshpere</u>
  - 40 to 250 miles above sea level
  - Deep layer of electrically charged molecules and atoms
  - Aids in the reflecting of radio waves back to earth
  - Is also known for its *auroral displays* or the Northern Lights.
  - Found in the Thermosphere

Human-Induced Atmospheric Change (What have we done?)

- Depletion of the Ozone Layer
- Hole in the Ozone Layer
  - Chlorofluorocarbons most problematic chemicals used by humans that depleted the Ozone.
  - Thinning of the Ozone Layer allows for Ultraviolet rays to reach the surface of the earth

- In the polar areas (Antarctica), the ice crystals form a place for chlorine based molecules to form. In the spring they trigger a catalytic reaction and the Ozone is depleted even more than in the other latitudes.

Air Pollution

- Smoke
- Sulfur Compounds
- Nitrogen Compounds
- Photochemical Smog
- Consequences of Anthropogenic Air Pollution
  - Damages our health
  - Damages the plant life

Weather and Climate

- **Weather…**
  - Short-run atmospheric conditions that exist for a given time in a specific area.
  - The sum of temperature, humidity, cloudiness, precipitation, pressure, winds, storms, and other variables for a short period of time
  - Weather is in an almost constant state of change
- **Climate……**
  - The generalized variations of the weather
  - The aggregate of day-to-day weather conditions of a long period of time.
  - Has averages, variations and extremes
- **Weather and Climate have direct and obvious influences on agriculture, transportation, and human life, and the physical land.**

Four Elements of the Weather and the Climate

- **Temperature**
- **Moisture content**
- **Pressure**
- **Wind**

Controls of the Weather and Climate

- **Latitude**
- **Distribution of Land and Water**
- **General Circulation of the Atmosphere**
- **General Circulation of the Oceans**
- **Altitude**

- **Topographic Barriers**
- **Storms**

The Coriolis Effect or Force

- Appearance of all things drifting sideways as a result of the Earth's rotation.
- Why.. If a rocket is shot directly at New York, by the time the rocket arrives at New York, the Earth has rotated and the rocket seems to have "drifted"
- Applies to any freely moving object.

Four Basic Points of the Coriolis Effect

- 1. Regardless of the initial direction of motion, any freely moving object appears to deflect to the **right** in the Northern Hemisphere and to the left in the Southern Hemisphere
- 2. The apparent deflection is **strongest** at the poles and **decreases** progressively toward the equator where there is zero
- Four Basic Points of the Coriolis Effect
- 3. The Coriolis Effect is **proportional** to the **speed** of the object, so a fast-moving object is deflected more than a slow one
- 4. The Coriolis Effect **influences direction of movement only**… it has **no effect on speed.**

Major importance of the Coriolis Effect

- **All winds** are affected by the Coriolis Effect
- **Ocean currents** are also deflected by the Coriolis Effect
- The Coriolis Effect may or may not affect the direction of the flow of the water as it drains down the sink.